Multifunctional Graphene Nanocomposite Foams for Space Applications

Completed Technology Project (2012 - 2016)

Project Introduction

Materials combined with a small amount of nanoparticles offer new possibilities in the synthesizing of multifunctional materials. One novel nanomaterial is graphene which consists of sp2 covalently bonded carbon atoms arranged in a planar hexagonal structure. The graphene structure has excellent mechanical, thermal, barrier, flammability reducing and electrical properties. A procedure developed at Michigan State University is able to create graphene sheets 1-5 layers thick in diameters ranging from less than 1 micron to over 100 microns. These graphene nanoplatelets show comparable properties to single graphene layers but are in a more robust form and can be produced at cost competitive prices compared to other additives and fillers. Polymer foams are one such material that can benefit from the addition of graphene nanoplatelets. The addition of these graphene nanoplatelets to a polymer foam offer the potential for improved mechanical, thermal and electrical properties, at an overall lower cost that allows the foam to maintain its unique cellular structure and low density. A foam material with such combination of properties has potential applications in space technology; as the resulting nanocomposite foam would have ranges of stiffness and resilience that are outside the limits of pure polymer foams, be flame resistant, demonstrate electrical and thermal conductivity and yet be both light weight and cost effective space stable materials. This research is directed at understanding the physical and chemical challenges associated with embedding graphene nanoplatelets in the struts and cell walls of a polyurethane foam in order to achieve percolation. Polyurethane foam can be synthesized using a simple process involving the combination of two components, an isocyanate and a polyol blend that contains a liquid blowing agent, that upon mixing form urethane and evolve gas. The nanoplatelets can be added to the precursors prior to mixing to ensure adequate dispersion. Reaching the percolation threshold requires balancing the particle size, surface area and concentration that allows for the formation of the nanoplatelet network but keeps the precursors viscosities low enough to allow the foam to rise. This also depends heavily on achieving and maintaining a good dispersion through the conjoined effort of mechanical dispersion techniques and an investigation on the effect of functionalizing the nanoplatelets. These studies will contain important information for future technologies involving the use of graphene nanoplatelets to structure nanocomposites. Investigating each of these aspects will help to determine the best GnP selection and dispersion methods to create the optimal multifunctional nanocomposite foam for space applications and can be easily translated to other industries by tailoring the constituents.

Anticipated Benefits

These studies will contain important information for future technologies involving the use of graphene nanoplatelets to structure nanocomposites. Investigating each of these aspects will help to determine the best GnP

Project Image Multifunctional Graphene Nanocomposite Foams for Space Applications

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

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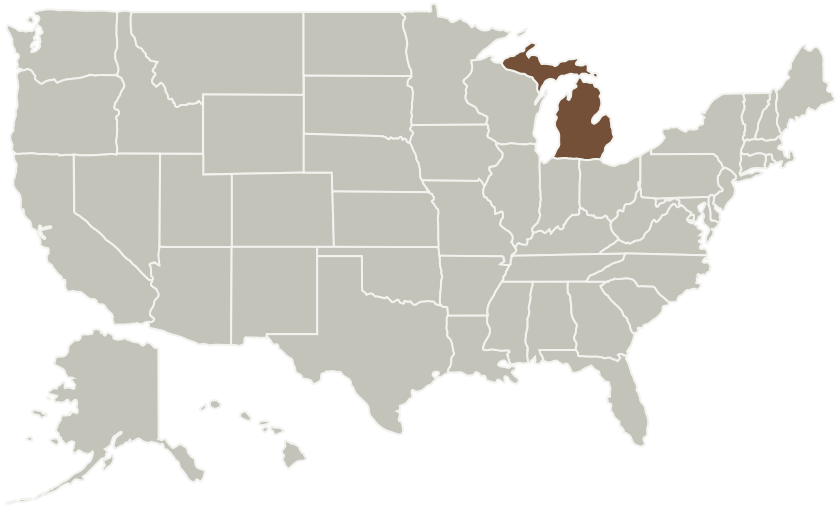
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Michigan State University	Supporting Organization	Academia	East Lansing, Michigan

Primary U.S. Work Locations
Michigan

Project Management

Program Director:
Claudia M Meyer

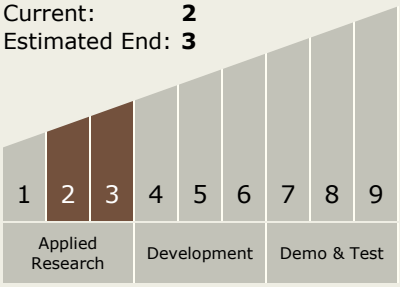
Program Manager:
Hung D Nguyen

Principal Investigator:
Lawrence Drzal

Co-Investigator:
Diandra J Rollins

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.1 Materials
    - TX12.1.1 Lightweight Structural Materials

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Images

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(https://techport.nasa.gov/image/1800)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html